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2017 RDD Economic Consequences Study

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Lawrence Trost, Vanessa Vargas, Drake Warren, Robert Knowlton, William Fogleman, Emma Grazier

ORS PM: Mark West

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Motivation and Outline

Develop an updated understanding of the consequences and impacts from the malevolent use of radiological material (e.g. RDD).

- Significant economic impacts shown by NA21/ORS study in 2006-2008 by LANL & SNL.
- New modeling tools and data from Fukushima, as well as other incidents, since 2008 allow for more rigorous analysis.
- Develop insights beyond “the” number.

BLUF:

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An RDD can cause significant economic consequences and disrupt an area for a decade or longer

The impact was sizeable:

- US GDP impact
- Deaths/serious injuries from dispersion explosion.
- 195,000 people evacuated.
- Significant deaths from evacuation based on Fukushima experience.

It could have been worse:

- Resilient NYC critical infrastructure robust to contamination or not in the plume: no cascading impacts.
- Prompt response and resilience efforts significantly reduce the economic impact when compared to past study.
- Shelter in place and controlled evacuation minimized the human impact and prevented latent cancers.

Outline

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- Motivation and Summary
- Approach
- Physical Impacts
- Response Phases
- Economic Impacts
- Summary

Analysis in three parts:

Physical, Response, and Economic

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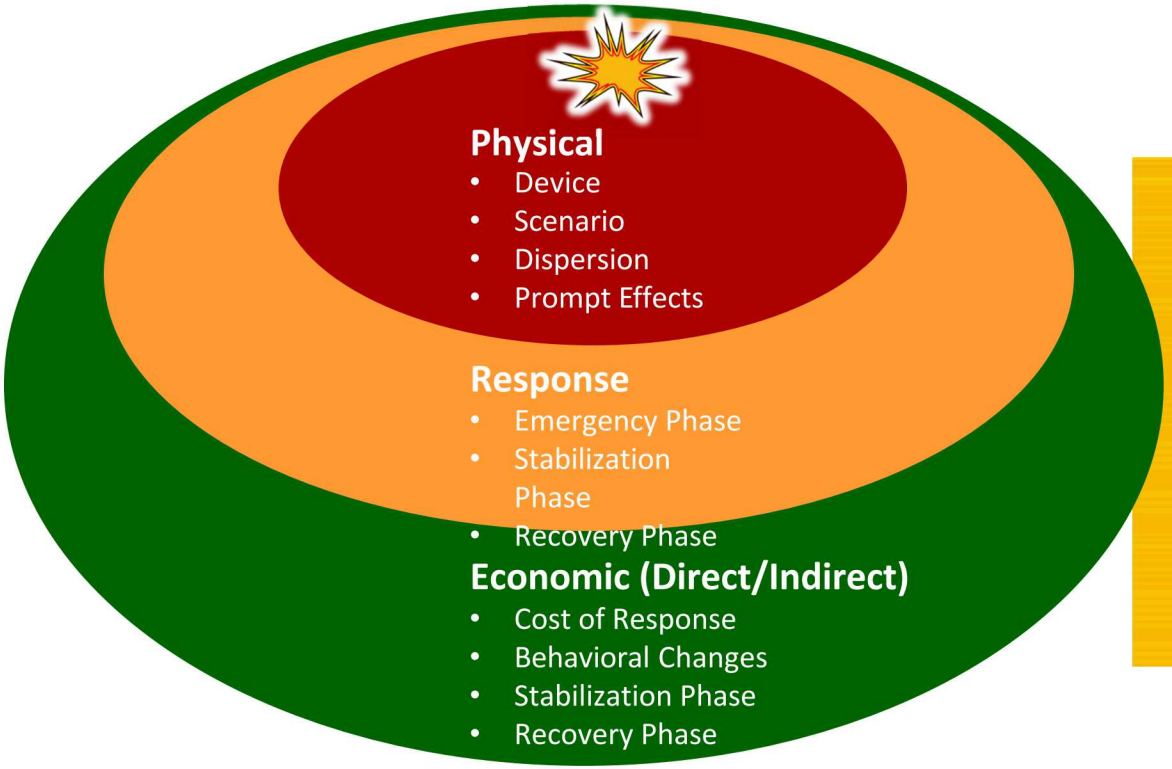
Tools/Data

- **Dispersion Modeling:** QUIC for dispersion, PARAT* for indoor infiltration; and BGM* for subway infiltration.
- **Prompt Effects:** Explicitly modeled.
- **Response Efforts:** Taken from NYCEM guidelines*.
- **Remediation Costs:** PATH/AWARE* used.
- **Economic Analysis:** Modeled over multiple years with REAcct* and REMI*.



*Not available for earlier study

Estimate Cumulative Impacts:

Estimate Impact from Physical and Infrastructure Impacts

Objective

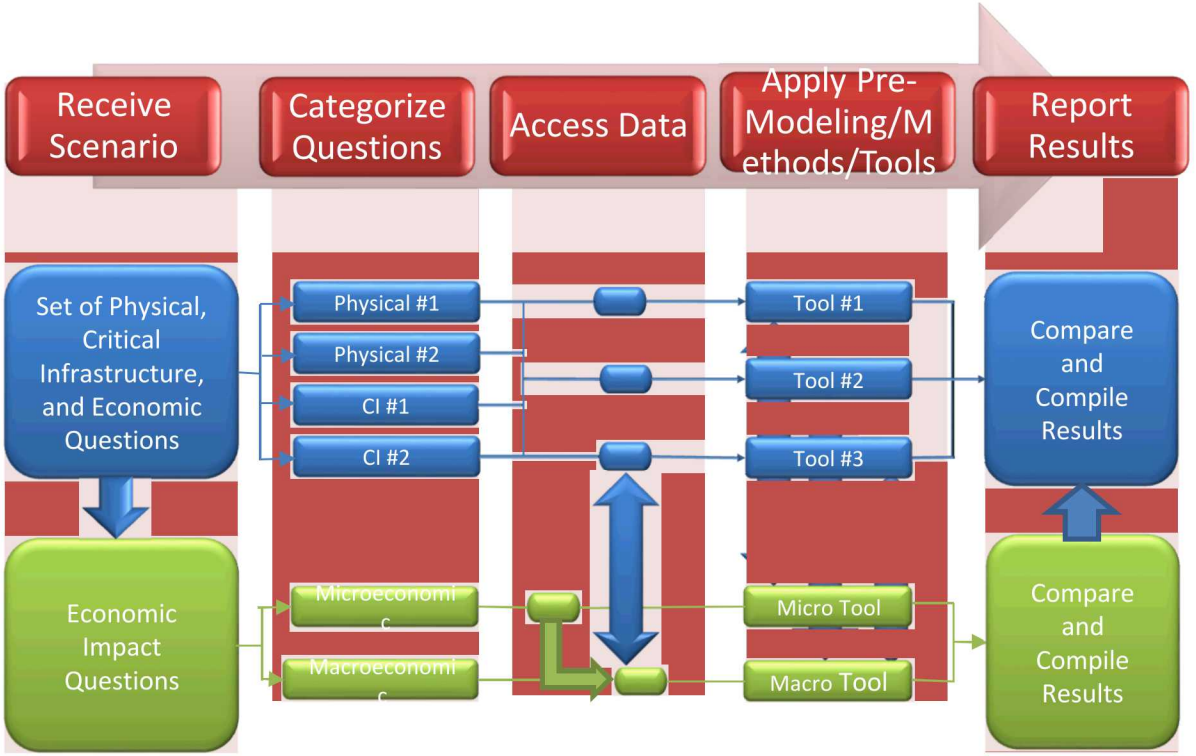
- Estimate cumulative economic impacts

Challenges

- Data acquisition, parameter specification, and modeling assumptions
  - Previous study not helpful

Solutions

- Outreach to stake-holder and subject matter experts
  - **NYC EMD**
  - Interagency review of methodology and assumptions
  - Identified new or state of the art Physical and Infrastructure model or data



Representative not worst case scenario. Leveraging of existing research of similar scale events

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The Dispersion Extends Across Lower Manhattan and Brooklyn, but Quickly Falls Below Response Levels

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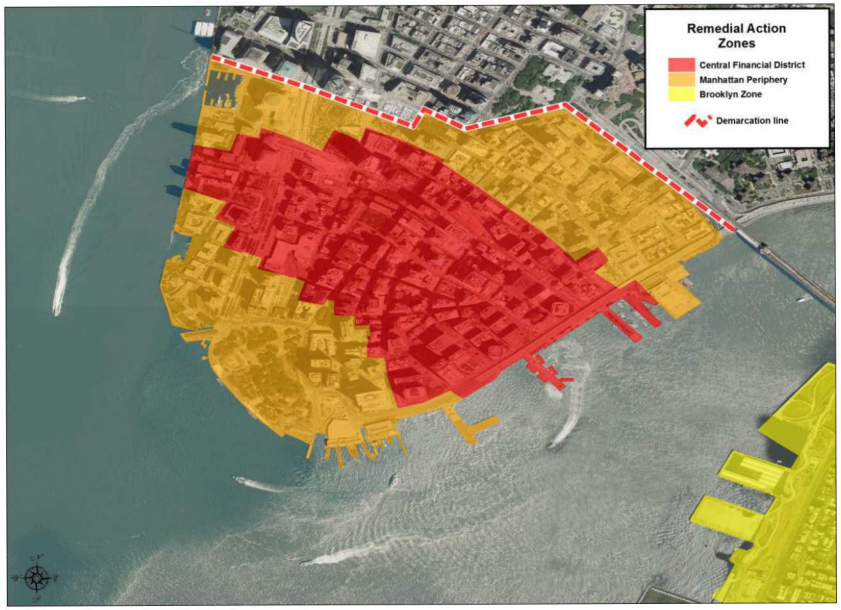
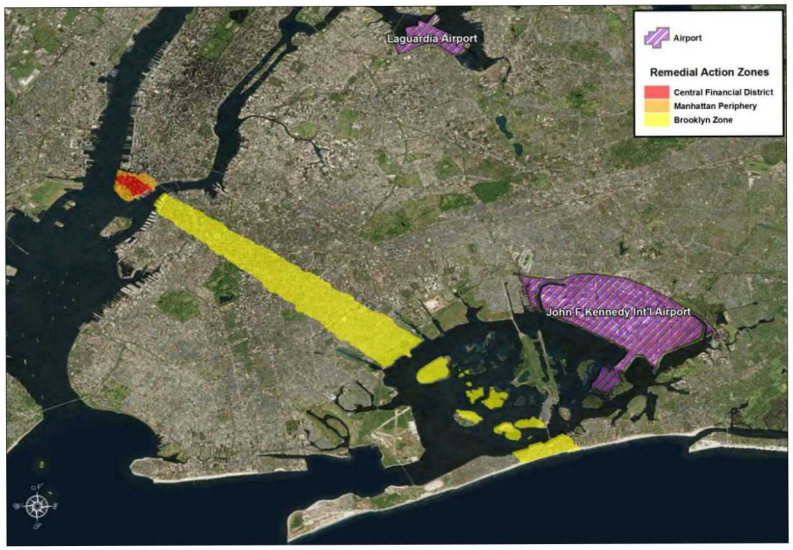




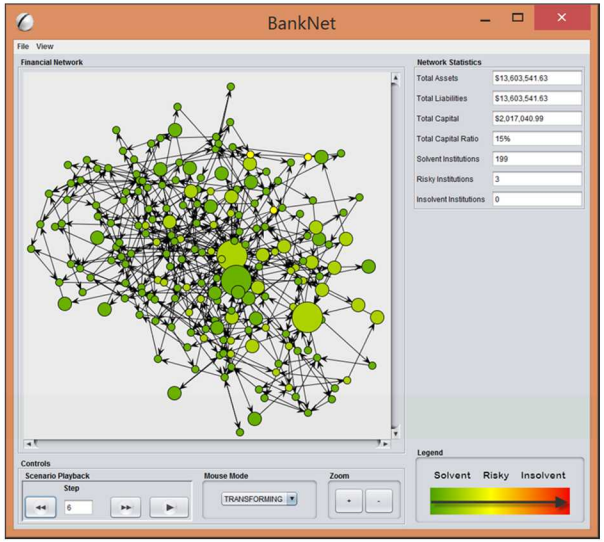
Plume large but missed air and seaports.

Impacts heavily dependent on a threshold for action, which is not mandated by US Gov.
Study used EPA PAG relocation threshold of 500mrem/2yr, which the area in Brooklyn didn't exceed.

No Direct Infrastructure Sector Impacts

- **Communications**
  - The equipment itself will suffer no impacts
  - Access restrictions will be more inconvenience than operational
- **Electric Power**
  - Limited backup generation within impact area
  - Exposed equipment will suffer no impacts
  - Transmission and distribution assets principally underground
- **Transportation Fuels**
  - Adaptive supply chain mitigates the effects on supply
  - Human evacuations may cause impacts on product consumption
- **Financial System**
  - Major market data centers are outside the disrupted area
  - Redundancies in financial system networks designed for continuity

Flows and storage in Colonial and Buckeye pipelines



Financial interconnections among banks

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Timelines with Response Activity by Area

Event (40 min.)	Emergency Phase (4 days)	Stabilization (10 days)	Recovery (10 years)	
				
▪ Plume rises following release. ▪ Plume extends beyond Manhattan and Brooklyn into ocean. ▪ Serious casualties from bomb blast only.	▪ NYCEM protocol: shelter in place. ▪ No surface access to Battery Park. ▪ All businesses shut down. ▪ Some subways stations closed.	▪ Demarcation determined by protocol. ▪ Survey, evacuation and relocation.	▪ Indoor / Outdoor decon and disposal. ▪ Exterior and interior remediation.	▪ Brooklyn below response levels. ▪ Some wash down of public buildings.

Assumed perfect availability of resources

Event lasts for 40 minutes. However, remediation can last 10 years. Response protocols determine cost and human impact to a great extent.

Recovery Phase:

Indoor Infiltration Dose Relatively Low

Indoor dose is below PAG levels of concern: 2x10^{-12} to 2x10^{-2} mrem/yr

Simulation:

- Estimate amounts of cesium that infiltrate and deposit on surface areas (floor) and occupants

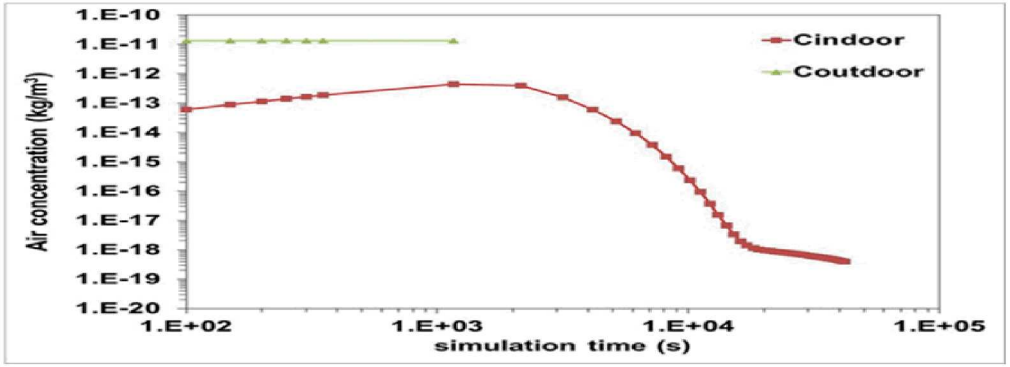
Concentrations:

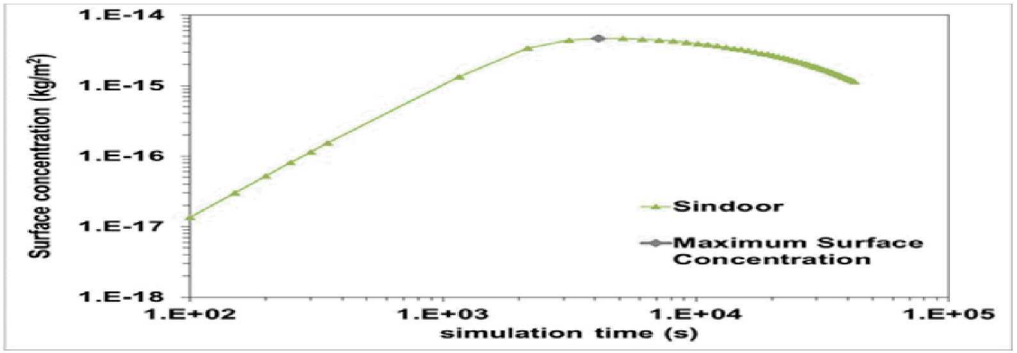
- Calculated as a function of time for 100 discrete buildings within the plume

Uncertainty:

- Fomite transport could increase contamination levels

Air Concentration





Surface Concentration

HVAC recirculation/filtration demonstrate structural resilience.

Recovery Phase: Decontamination Activities Differ by Zone, Level of Effort

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Manhattan – Major Remediation

- **Streets, sidewalks, and open spaces**: removed and resurfaced
- **Building interiors**: decontaminated using scabbling and strippable coatings
- **Rooftops**: scabbled or stripped of their membranes
- **Building facades**: removed and replaced if possible. Scabbling and/or demolition are last resort.

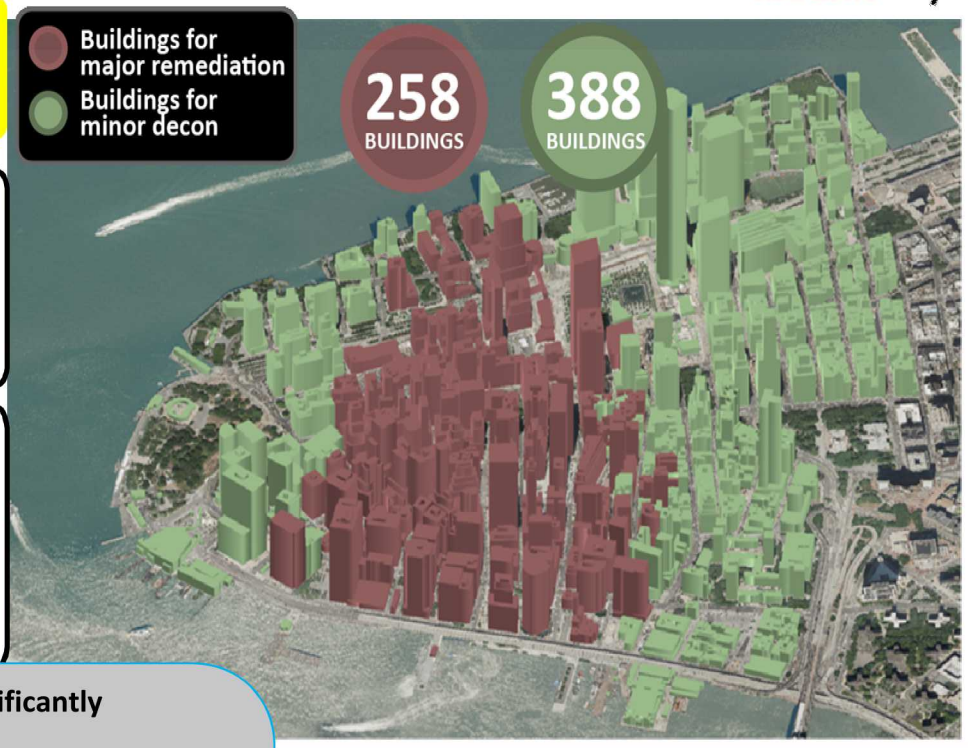
Manhattan – Minor Remediation

- **Interior floors, walls, and ceilings**: decontaminated using strippable coatings

Brooklyn

- **Private property**: owners will assume responsibility for cleanup (if any)
- **Public buildings:** interior floors will be decontaminated using strippable coatings

Resilient Construction = Remediate **Red Zone** only



Façade Replacement Reduces Costs Significantly

Does the building have a removable façade?

- **Yes** → **Remove and replace the façade**
- **No** → **1. Scabbling** (preferred method)
  - **2. Demolition** (last resort if scabbling not possible)

Building-by-building analysis reduces cost and time from one size fits all approach. Costs highly dependent on actual DF effectiveness

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Total U.S. Impact : GDP Losses occur over 10 Years

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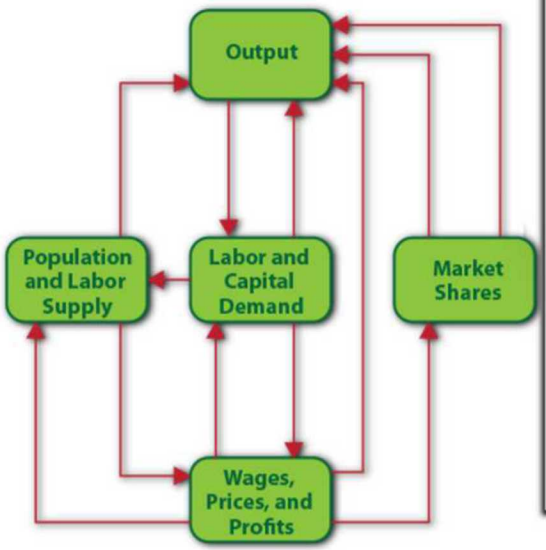
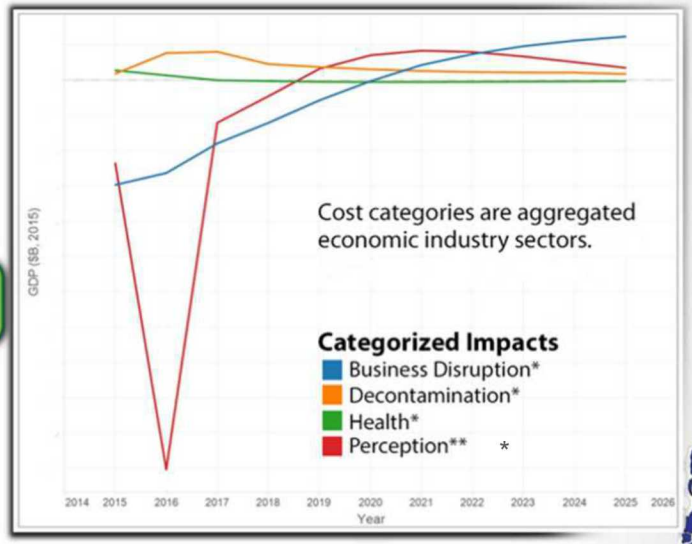
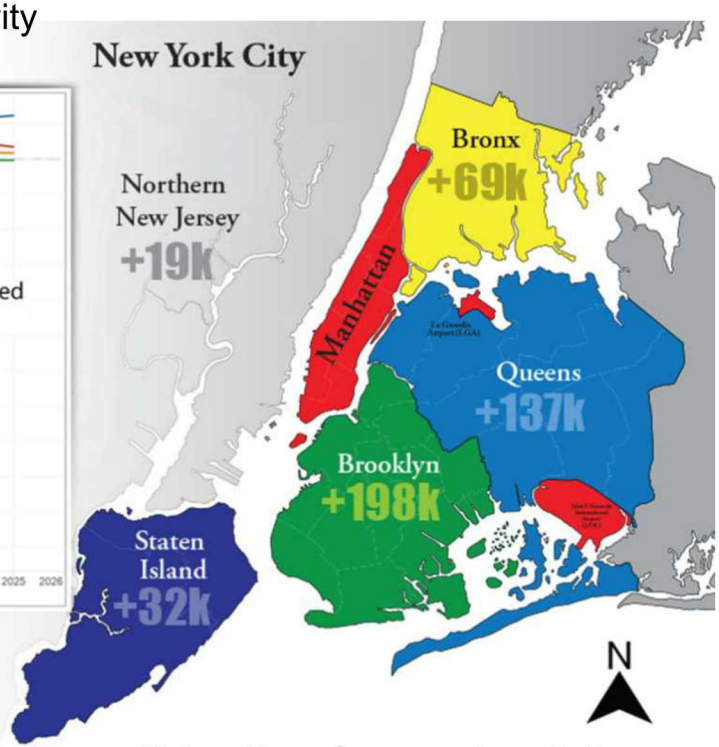
The economy: circular and dynamic



Output (GDP) contributed by activity





Output generates employment, employment generates income, income generates demand for and spending on new output, new output generates new employment, *and so on*.

***Recovery efforts are likely to be funded by federal government spending, resulting in increases in output.**
****** Perception is based on tourism patterns observed post-Fukushima.**

Relocation of economic activity within the NYC MSA. It is assumed businesses and employees will behave similar observed post 9/11 relocation patterns.

GDP impacts are not intuitive. They can be negative or positive, but all represent economic disruption.

The Insights Are as Important as the Numerical Data

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- **Cost and human impact drivers:**
  - Evacuation deaths could be significant.
  - Perception and avoidance had largest negative impact, not clean-up.
  - Low interior contamination levels, per modeling, reduced clean-up costs significantly from first study.
- **Regional/national effects:**
  - Regional impacts vary tremendously with some positive offsets.
  - First year cost categories had significant down turn, but multi-year analysis showed some recovery.
  - Limited national effects found in the analysis.
- **Lack of resilient infrastructure and planning can increase impact:**
  - Enhancements to Critical Infrastructure post-9/11 created a “built” in resilience.
  - No cascading infrastructure impacts.
  - Modern construction techniques return capital to productive use.
  - Business relocation can affect the ability to recover.
  - Delays in remediation actions due to limited resources or delayed decisions.
  - Lower contamination action level and/or lower decontamination factors than used by the study.